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PRACTICAL DISINFECTION IN SCHOOLS.

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THE importance of the subject matter of this paper largely depends on the circumstance that, in the case of schools, we are dealing with a section of the population drawn from widely separated areas, confined in a relatively small space, and at an age highly susceptible to the attack of infectious disease.

As it is proposed to treat the subject in as practical a manner as possible, it is of advantage to pass at once to a brief account of the history of disinfection.

HISTORY OF DISINFECTION.

The history of disinfection is an interesting one, but, from the point of view of this paper, it is advisable to limit the discussion to modern times

In 1884 Dr. Parsons laid it down as an axiom that the destruction of the most stable known infective matter is the test of true disinfection.[2] The late Sir George Buchanan (then Dr. Buchanan) set the seal of his high authority on this opinion; and it is not too much to say that the views of Drs. Buchanan and Parsons, aided by the bacteriological researches of Dr. Klein, have largely governed the practical procedure adopted by responsible sanitary authorities in this country in their efforts to check the spread of infectious disease. Dr. Parsons' conclusions as regards disinfection by heat are so important that they have been given in full in Appendix A. It is of advantage, however, to here quote from Sir George Buchanan's summary as follows:—

"Dr. Parsons came to the conclusion that all infected articles which could be treated by boiling water, so as to penetrate the

substance efficiently by this means without injury to the articles themselves, could not be so well disinfected in any other way as by simply boiling for a few minutes; that infected articles which from their nature did not lend themselves to such boiling had best be treated with high pressure steam, with such arrangement as would insure complete penetration of the steam at its high temperature, and that such treatment might be relied on to destroy any infective quality in them with the thoroughness and rapidity that were desired; and that in the comparatively few cases where the articles to be disinfected would be injured by steam, a dry heat of 240° F. would, if sufficiently prolonged, bring about the desired destruction of infection, but that this could not, in the case of most articles, be had by means of dry heat without an inconvenient length of exposure."

At and before this period, Dr. J. B. Russell, then Medical Officer of Health for Glasgow, had placed reliance on thorough washing with soap and soda in boiling water.[3]

Previous to Drs. Parsons' and Klein's important communication on disinfection by heat, Koch and his colleagues had been carrying out in Germany a series of valuable experiments on the disinfectant values of various chemical agents and of dry and moist heat.[4] As regards chemical agents, they proved the comparative uselessness of many substances reputed to be powerful germicides, and the real value of a few, notably corrosive sublimate. In respect of dry heat, they concluded that non-sporing bacteria cannot withstand a temperature a little over 212° F. Further, that the penetration of heat (dry air) was so slow as to be unreliable in the case of bulky objects, and was apt to be attended by injury to most materials. As regards steam (moist heat), the results were much more satisfactory, anthrax spores being killed in five minutes at a temperature of 212° F.

The Committee on Disinfectants of the American Public

Health Association (appointed in 1884), after carrying out a prolonged investigation, submitted in 1887 their final report. The conclusions are of such value that I have placed them in a special Appendix (Appendix B).

Within recent years much valuable work has been carried out in this country by Drs. Sheridan Delépine, Ransome, Sims Woodhead, Kenwood, Mackenzie, and others too numerous to mention. The conclusions of some of these authorities have been placed on record in appendices accompanying this article. Chief progress seems to have been made as regards gaseous disinfection (notably formalin), and spraying and washing the walls, etc., of infected rooms with germicidal substances (*e.g.* solution of chlorinated lime). Quite recently Drs. Klein, Gordon, and Houston carried out some experiments on disinfection on behalf of the London County Council.[5] These also have been summarised and placed in Appendix C.

GENERAL OBSERVATIONS.

It is of advantage here to point out that the subject of disinfection, instead of being, as many suppose, a very simple matter, really involves problems of considerable complexity, many of which remain quite unexplained.

For example, we have no real knowledge of the precise manner in which germicidal substances produce their observed result, viz. disinfection. Further, we are at a loss to explain why some substances should be such powerful antiseptics and at the same time so feeble in germicidal power.

Nor is it easy to understand why certain agents of small human toxic power should, nevertheless, be so fatal to bacterial life.

Again, while it is easy to understand why of any particular disinfectant a much larger proportion is required to kill spores than bacilli, it is puzzling to find that some substances act more

powerfully on spores than their action on bacilli would lead one to expect; and, conversely, that other substances in relation to their powerful germicidal action on bacilli are relatively inert where spores of bacteria are concerned. Lastly, we have but a superficial acquaintance with the laws which govern the fact that some disinfectants act quickly and others act only very slowly.

In conclusion, it may be said that one thing is absolutely clear, viz. that in practical disinfection the choice of the disinfectant must largely be governed by the purpose to which it is proposed to put it. A germicidal substance under one set of conditions might be useless, under others extremely valuable.

SUMMARY OF PRACTICAL MEASURES TO BE ADOPTED.

Before giving this summary I may point out that very few medical men would care to make a very definite statement with regard to each individual disease whether or not it was really communicable, and if so the manner of spread of the virus in each case.[6] But all cases of serious illness in schools should perhaps be considered infectious, at all events until a final diagnosis of the complaint has been made. Further, the urine, fæces, perspiration, breath, skin, hair, and the secretions of the mouth, ears, and eyes, should all be considered as possible means of spreading disease.

SUMMARY.

1. Disinfection of rooms.
   - A. Gaseous disinfection.
   - B. Spraying and washing the walls with disinfectant solutions and rubbing the walls with stale bread.
2. Disinfection of the contents of the room, apart from the bedding and clothes. For example, furniture, books, shoes, boots, etc.
3. Disinfection of mattresses, blankets, carpets, hangings, clothes, under garments other than linen, etc.

4. Disinfection of the excreta, etc.
5. Disinfection of linen.
6. Disinfection of cups, saucers, plates, spoons, forks, knives, etc.
7. Disinfection of convalescents and the attendants on the sick.

I. DISINFECTION OF ROOMS.

A. *Gaseous disinfection.*—As regards the gaseous disinfection of rooms, it is necessary to make a preliminary observation, namely, that as the microbes are not "chained down to points in space," aërial disinfection is hardly necessary. Efficient ventilation and "dilution of the poison" is all that is really required.[7] During the progress of a disease, aërial disinfection, indeed, might be deemed to be advisable if any agent were known of the slightest value which could be used without causing discomfort, if not endangering the life of the patient. After the removal of the patient (the source of the poison) aërial disinfection is no longer required. I therefore conclude that during and after the occurrence of infective disease, the only aërial disinfectant, in the first case applicable, and in the second case necessary, is an abundance of fresh air. But gaseous disinfection is of none the less value on this account, as the real object sought to be attained is the destruction of microbes superficially attached to the walls, ceiling, and floor of the room, lodged in crevices, mixed with dust, and distributed over the various articles of furniture.

No special reference need be made to (1) chlorine and (2) bromine, as these agents have of recent years been supplanted by (3) sulphurous acid gas and (4) formic aldehyde vapours.

As regards (3) sulphurous acid gas, opinions naturally vary considerably, but most authorities now consider that, if sulphur dioxide is good, formalin is still better. Dr. Kenwood, a former advocate of sulphurous acid gas, now prefers formic aldehyde (Appendix D), and Professor Sheridan Delépine is of the same

opinion (Appendix E). In the London County Council experiments (Appendix C) we found sulphur dioxide reliable, under the conditions of our experiments, as regards B. typhosus, B. diphtheriæ, B. pyocyaneus, V. choleræ, and S. aureus; but unreliable as regards tubercular sputum and spores of B. anthracis. As Dr. Newman and others have pointed out, much depends on keeping the air of the room moist during the process of disinfection. Its injurious action on many household goods is a serious disadvantage, and in this respect it compares unfavourably with formalin.[8]

Personally, I think that a fair amount of reliance may be placed on sulphur dioxide, provided the air of the room is kept moist, 3 to 6 lb. of sulphur burned to every 1,000 cubic feet of space, the room securely sealed up and left undisturbed for twenty-four hours.

As regards (4) formic aldehyde, the general consensus of medical opinion is clearly in favour of this substance yielding superior results to all other gaseous disinfectants. The conclusions arrived at by Dr. Kenwood and Professor Sheridan Delépine have been placed on record in Appendix D and Appendix E. At the period, however, when Dr. Kenwood's results were discussed (Congress of the Sanitary Institute at Leeds, in 1897), Professor G. Sims Woodhead took a less sanguine view than his colleagues of the value of formalin. Dr. Rideal carried out a series of experiments with the alformant lamp, and came to the conclusion that by using 10 grammes of para-formaldehyde for every 1,000 cubic feet disinfection was reasonably perfect.[9] The experiments of Drs. Klein, Gordon, and Houston (Appendix C) seemed to show that, although formalin was more satisfactory as regards tubercular sputum than sulphur dioxide, neither of these disinfectants could be wholly relied on to kill either the tubercle bacillus or anthrax spores. The results were satisfactory as regards B. typhosus,

B. diphtheriæ, B. pyocyaneus, V. choleræ, and S. aureus. Nevertheless, in one experiment B. typhosus on wood and cloth escaped destruction.

You are all familiar with the different forms of apparatus used for formalin disinfection, *e.g.* Trillat's autoclave,[10] and the convenient alformant lamp (paraform). But it is probable that most of you have had no experience of Lingner's (glycoformal) apparatus. Dr. Klein quite recently drew my attention to the merits of this apparatus, and I had the advantage of seeing some of the results of his experiments with it. The apparatus in question has been reported on most favourably by the highest authorities on the Continent and abroad. But as I was particularly anxious to come before you in the position of one who has taken the pains to test personally the methods of disinfection which he ventures to recommend, I wrote to Dr. Newman on the subject. The result was that, although the time at our disposal was necessarily short, we, nevertheless, managed to test practically Lingner's apparatus, and to satisfy ourselves that confidence in it was not ill-placed. It is true that in the first series of experiments, in which perhaps our tests were unnecessarily severe, the results were unsatisfactory; but in the second series the results were uniformly successful, and this under conditions representing as nearly as possible those likely to occur in actual practice. These results are placed on record in Appendix F, together with those obtained by Dr. Klein and foreign observers.

Although it would be necessary to carry out a prolonged series of experiments before coming to any final conclusion in the matter, I think that I may tentatively assert that Lingner's (glycoformal) apparatus is likely to place gaseous disinfection on a surer footing than it has ever enjoyed in the past.[11]

As has been already pointed out, the fact that formalin, unlike sulphur dioxide, exerts little or no injurious action on leather, polished wood, coloured fabrics, etc., is a strong point in its favour.

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A very pertinent question arises in connection with the proved efficacy of formalin disinfection, namely, how far can we dispense with the separate disinfection by steam of wearing apparel, mattresses, and bedding? Previous to my experience of Lingner's (glycoformal) apparatus, I should have answered the question without much hesitation in the negative. As the matter stands, all that can be said is that no disinfectant can compete with exposure of the infected articles to saturated steam at 115° C. for thirty minutes, but that possibly the newer forms of gaseous disinfection may be considered, in view of their great convenience, to afford sufficient protection.

B. *Spraying and washing the walls, etc., with disinfectant solutions and rubbing the walls with stale bread.*—On the Continent rubbing the walls with stale bread is considered an effective measure; spraying with corrosive sublimate solution is also resorted to. The "bread method" has never been much in favour in this country, and the use of corrosive sublimate is attended with obvious disadvantages.

Professor Sheridan Delépine has consistently advocated the use of a solution of chlorinated lime (1 per cent.) as a spray or wash. His conclusions, jointly with those of Dr. Ransome, are recorded in Appendix G.

That chlorinated lime is a most powerful germicidal substance is known to everyone; but it must be remembered that, owing to its energetic oxidising action, it may be used up in attacking organic substances, and so fail to exert its full germicidal action on bacteria. Further, when used as a spray or wash, much of the available chlorine must be lost by evaporation. Formalin solution (1½ to 2½ per cent.) may also be used for washing and spraying the walls. Dr. Rideal favours this substance, because, like sulphurous acid, it is a reducing agent; but the strength which he recommends, 0.5 per cent., is, I think, hardly sufficient.[12] It must needs be remembered

that spraying or washing operations, to be effective, ought to cover every square inch of the surface to be disinfected, a procedure easy in theory, but doubtfully so in actual practice. Moreover, mere washing or spraying with water apart from the bleaching action of chlorine must needs injure wall papers to some extent. There is decided advantage in combining gaseous disinfection with spraying or washing of exposed surfaces. But as there is a very natural objection to carrying out two processes when one may be considered reasonably efficient, I conclude that, exceptional cases apart (*e.g.* tubercle infected houses), disinfection with formic aldehyde vapour is to be preferred to the spraying or washing with disinfectant solutions. But, as regards the floor of the room, thorough washing is very important, and here corrosive sublimate 1 : 1,000; carbolic acid 1 : 50; and izal 1 per cent., are all reliable germicides. It need hardly be added that when a wall paper is old, or a ceiling dirty, the opportunity for stripping off the paper and lime washing the ceiling is a good one.

In conclusion, as a counsel of perfection, I should recommend the use of Lingner's (glycoformal) apparatus combined with spraying or washing the walls with some germicidal solution; but in ordinary cases of infectious disease, gaseous disinfection with formalin vapour, preferably Lingner's apparatus, and washing painted or varnished surfaces and scrubbing the floor with one or other of the disinfectant solutions that I have already mentioned may be considered sufficient.

2. DISINFECTION OF THE CONTENTS OF THE ROOM APART FROM THE BEDDING AND CLOTHES. FOR EXAMPLE, FURNITURE, BOOKS, BOOTS, SHOES, ETC.

All washable surfaces should be thoroughly washed with a disinfectant solution.[13] The furniture, books, boots, and in general articles liable to be damaged or incapable of being

dealt with by steam disinfection may be sterilised with formalin at the same time as the room is being disinfected.

As regards books, those of little value should be burnt; the rest, after formalin disinfection, may perhaps be used again with safety, or else stored as an extra precaution in a library specially devoted to the use of infectious patients.[14] There seems no reason why some shelves should not be devoted to "measles books," others to "scarlet fever books," and so on.[15]

Some of the articles mentioned may be sterilised by means of dry heat, but it is difficult to secure certain and rapid sterilisation without risk of injuring them.

3. DISINFECTION OF MATTRESSES, BLANKETS, CARPETS, HANGINGS, CLOTHES, UNDER GARMENTS OTHER THAN LINEN, ETC.

The bacteriological researches of Dr. Klein, combined with the practical experiments of Dr. Parsons, carried out in 1884, leave no ground for doubt that implicit reliance may be placed on *moist heat*, if properly applied. As boiling is out of the question in connection with mattresses, etc., disinfection by means of steam must be resorted to.

I may sum up the position at the present time by quoting Dr. Newman as follows: "The disinfecting temperature which is now used as a standard is *an exposure to saturated steam of* 115° *C. for thirty minutes.*"[16]

The only rival to this method is burning, and I believe in some schools the oldest bedding materials are used for those suffering from infectious disease, and destruction by fire is resorted to at the conclusion of an illness. But obviously this does not cover the contingency that a boy previous to diagnosis of the nature of his illness may have already infected his surroundings.

Although exposure to saturated steam of 115° C. for thirty

minutes may be taken as the standard, it ought to be added that Professor Sheridan Delépine in 1897 clearly showed that excellent results might be obtained by *current steam at* 103° *to* 104° *C. in fifteen minutes;* see Appendix H.

As regards the best method of removing the bedding, clothes, etc., to the disinfecting station, and which of the well known steam disinfectors, *e.g.* Washington Lyon, Reck, Thresh, Equifex, should be employed, I prefer to make no definite statement. It is a matter which must depend largely on local circumstances, and it is one concerning which I have had no special experience.

The question naturally arises:—Is it not possible to combine the disinfection of rooms with the sterilisation of the bedding, etc.—in short, to dispense with a double process?

All that can be said in this connection is that while nothing can supersede steam in the sterilisation of bulky objects, the results obtained by the various authorities who have practically tested Lingner's glycoformal apparatus almost seem to indicate that at all events the superficies of clothes, bedding, and under garments could be effectively dealt with at the same time as the room was disinfected.

4. DISINFECTION OF THE EXCRETA, ETC.

The importance of this subject is obvious. Recent researches have clearly shown that the morbid discharges of the body may even during convalescence be a much more fertile means of spreading disease than has been supposed in the past. In the absence of convincing proof to the contrary, the urine as well as the fæces should be regarded with suspicion in all cases of infectious disease. As regards morbid discharges from the nose, ears, and throat, these are generally received on linen or wool. In the former case the treatment should be that prescribed for infected linen; in the latter case the wool ought, of

course, to be burnt. As regards sputum and vomited matters, these should be treated broadly on the same lines as the excreta.

The American Public Health Association (see Appendix B) reported in 1887 in favour of chloride of lime (4 per cent. solution), and, in the absence of spores, carbolic acid (5 per cent. solution), and sulphate of copper (5 per cent. solution).[17]

In 1898 Drs. Hill and Abram carried out a useful piece of work on the disinfection of the excreta. Their results are given in Appendix I. These observers, in my opinion, place too much reliance on chinosol, and too little faith in bleaching powder, but their conclusions are of an eminently practical nature and merit careful consideration. In most respects I have been able to confirm their results as well as those of the American authorities above alluded to.

Being chary of recommending any method for the disinfection of excreta until I had first made some experiments of my own of a practical nature, I carried out recently a series of experiments, which is placed on record in Appendix J.

Before considering the results, I may point out that no method can compare with boiling the excreta, or even heating to 70 or 80° C. for five to ten minutes.[18] This plan was, I believe, successfully carried out in South Africa, and my only reason for not unhesitatingly recommending it is that I doubt whether it could be easily carried out without creating a nuisance.

The results of my experiments would seem to indicate that corrosive sublimate 1 in 500, izal 1 in 100, copper sulphate 1 in 20, and carbolic acid 1 in 20, are all efficient, the duration of contact being one hour, and the fæces being mixed as thoroughly as possible with the disinfectant solution. Bleaching powder (5 per cent.) in one experiment did not destroy all the spores of bacteria; but in another experiment a 1 per cent. solution was effective, both as regards spores and bacilli. Formalin, lysol,

cresol, and creolin were also experimented with and found to be of value.

As regards mixing the fæces, it is difficult to carry this out thoroughly, even under experimental conditions, and in actual practice it is open to question whether the attendants on the sick would or could always give sufficient time and attention to this important piece of procedure. I would not argue from this, however, that the attempt to sterilise the excreta is likely to be useless. It is of considerable advantage to sterilise the urine, the liquid portion of the stool, and the outside of the lumps of fæces. It is true that the bacteria in the interior of the lumps may subsequently prove a source of danger to the community at large; but it is better to economise our sympathy for general interests and protect our *immediate* surroundings than to attempt to do neither the one nor the other.

It will be noted that my experiments seem to show that simply pouring boiling water over a stool in amount sufficient to raise the temperature at the end of five minutes to 63° C. can effect the destruction of B. coli. The smell, however, is a serious drawback to the employment of this measure. But I found that the addition of 1 per cent. of permanganate of potassium removed this real objection. Assuming that a sufficient degree of heat would penetrate the interior of each lump of fæces, mixing might reasonably be dispensed with. As this is hardly a safe assumption, I should recommend the use of a *considerably larger proportion* of *boiling* water.

The standard of *complete* sterilisation of the urine and fæces of infectious patients is an ideal one; but in practice the destruction of the bacilli and not necessarily the resistant spores of bacteria is possibly a reasonably safe standard to adopt. With this modified standard in view, I suggest alternative plans, namely as follows:—

1. Add to the stool 1 to 2 pints according to its bulk of one of the following solutions :

Corrosive sublimate ..	1 : 500
(L.G.B. formula. B. W. & Co.'s Soloids, two to each pint.)	
Izal	1 : 100
Carbolic acid	1 : 40
Lysol	1 : 40
Cresol	1 : 40
Creolin	1 : 40
Copper sulphate ..	1 : 20
Formalin	1 : 20
Bleaching powder .. 1 pint, followed after ½ hr. by 1 pint dilute sulphuric acid	1 : 50

Mix as thoroughly as possible, and allow to stand at least 1 hr.

2. Add about 2 teaspoonfuls of the crystals of potassium permanganate to 2 pints of water in an enamelled vessel, bring to the boil, and pour the contents over the stool.

Mixing is to be recommended, but it is not so necessary as in method 1.

Allow to stand for ½ hour.[19]

Both as regard urine and fæces, a fair allowance is 4 parts of *boiling* water to 1 part of the substance to be disinfected. In the case of the urine, the permanganate may be dispensed with altogether or a small amount used.

Nevertheless, lest it be considered that my standards do not allow a sufficiently wide margin for safety, I recommend as a counsel of perfection: Corrosive sublimate, 1 in 500 (twenty-four hours); or boiling for ten minutes.

5. DISINFECTION OF LINEN.

The question of the disinfection of linen is most important. Within recent years we have come to learn that the urine as well as the fæces may be a fertile means of spreading enteric fever, and soiling of the linen with urine is impossible to avoid. How far, in the case of other diseases, the urine may be infective, it is impossible to state. The potentially, if not actually, pathogenic qualities of the perspiration and epidermis must also be borne in mind. Further, handkerchiefs soiled with the discharges of the nose or mouth must of necessity be a source of danger. Moreover, the infection of linen is a factor to be con-

sidered day by day during the whole course of an epidemic. Lastly, the opinions expressed by different writers on this subject are of so contradictory a character that it is difficult to arrive at any definite conclusion as to the best way to deal with infected linen.

For these and other reasons I felt that I could not make any definite statement on so important a matter without first making some experiments of my own of a practical nature. The results of these experiments are outlined in Appendix K.

It will be noted that my experiments show that the following disinfectants in the strengths stated killed B. coli on infected linen in one hour: corrosive sublimate 1 in 10,000, izal 1 in 250, carbolic acid 1 in 100, chloros 1 in 1,000.[20] Further, that 300 cc. of boiling water poured on to the handkerchief, the temperature at the end of five minutes being about 70° C. was effective in killing B. coli.

But as linen soiled with the mucous and other discharges of the sick may from a variety of causes be more difficult to sterilise as regards pathogenic microbes than my B. coli results would seem to indicate, I should recommend either steeping the linen for twenty-four hours instead of one hour in the disinfectant, or the use of the following agents in the strengths respectively stated:—

	In ordinary cases.	*In exceptional cases.*
Corrosive sublimate ..	.. 1 in 1,000 ..	.. 1 in 500
Izal	.. 1 in 200 ..	.. 1 in 100
Carbolic acid	.. 1 in 50 ..	.. 1 in 25
Chloros	.. 1 in 250 ..	.. 1 in 100

(Sodium hypochlorite).

Of these I should for a number of reasons specially recommend izal 1 in 100 (query 1 in 200), and corrosive sublimate 1 in 1,000 (L.G.B. formula, B. W. and Co.'s soloids, 1 soloid to 1 pint).

The above recommendations apply only to the destruction of

such infectious matter as is not credited with infectious qualities, in virtue of the presence of *spores* of bacteria. For *complete* sterilisation (destruction of the spores of bacilli as well as of the bacilli) reliance should be placed on corrosive sublimate 1 in 500 acting for one hour, or 1 in 1,000 for twenty-four hours.[21] But this counsel of perfection in actual practice may, perhaps, reasonably be neglected.

As regards heat, boiling the linen or even washing it in boiling water is quite reliable, and in many respects is to be preferred to steeping it in disinfectant solutions.[22] But, unless it is first soaked in cold water, stains may become fixed by this method. The soakings or washings would naturally require to be sterilised. It will be noted that the results of my experiments showed that a handkerchief steeped in an emulsion of B. coli and lightly wrung out could be effectively sterilised by merely pouring over it 300 cc. (about 10 oz.) of boiling water.

In conclusion I venture to recommend alternative plans, namely as follows:—

Steep the linen for 1 hour in a relatively large bulk of a solution of corrosive sublimate 1: 1,000 or Izal 1 : 100, wring out, and send it to the "wash" in the moist condition. Do not "wash" on the infected premises.

2. Steep the linen for 1 hour in cold water contained in a cauldron or vessel capable of being heated. Bring the water by heating to a temperature of 100° C.[23] After 10 minutes, or when sufficiently cool to handle, wring out the linen, and send it to the "wash," without preliminary drying. Do not "wash" on the infected premises.

6. DISINFECTION OF CUPS, SAUCERS, PLATES, SPOONS, FORKS, KNIVES, ETC.

For the disinfection of these articles nothing is so satisfactory as immersion in a sufficiently large bulk of boiling water

for a few minutes. Most chemical substances which have been suggested for this purpose are either poisonous, or act on metal goods, or are possessed of feeble germicidal power. The use of boiling water and thorough washing affords sufficient protection against re-infection, and the only objection is that knives with ivory or bone handles may suffer some deterioration.

Another plan is to partially fill with water a large vessel specially set aside for this purpose and capable of being heated, and drop in all the dirty cups, saucers, etc. Next bring by heating the temperature of the water to 100° C.[24] After ten minutes, or when sufficiently cool to handle, wash in the ordinary manner.

7. DISINFECTION OF CONVALESCENTS AND THE ATTENDANTS ON THE SICK.

During the acute stage of an illness it may be impossible or inadvisable to attempt much in the way of disinfection of the person, and the measures to be adopted must depend very largely on the nature of the illness. To take a single example, in enteric fever, Urotropin is certainly to be recommended if the patient is suffering from typhoid bacilluria.[25]

Intestinal disinfection has so far proved a comparative failure; but some recent experiments by Dr. Gordon are, to say the least of it, of an encouraging nature from the point of view of curative medicine.[26] But at present we know of no drug for internal administration capable of rendering the fæces non-infectious in the same way as Urotropin can render the urine innocuous.

As regards disinfection of the mouth and throat, no very hopeful view can be expressed. But gargling,[27] painting the throat, and washing the mouth with weak disinfectants may prove of some small service. The washings from the mouth should be further sterilised, the necessity for which implies that in the strengths used mouth washes are not reliable germicides.

Brushes used for painting the throat should be kept in a disinfectant solution.

The hands and surface of the body may be lightly sponged with corrosive sublimate 1 to 1,000, izal 1 to 200, or carbolic acid 1 to 50. But the difficulty experienced by surgeons in sterilising their hands places the disinfection of the general surface of the body on a doubtful basis. Nevertheless Mr. Bruce Clarke has reported very favourably on the use of izal in surgical practice.[28]

As regards baths, there is probably nothing better than soap and hot water, followed by light sponging with corrosive sublimate 1 to 1,000, or izal 1 to 200.[29]

After each motion the soiled parts should be wiped with absorbent cotton wool soaked in a weak disinfectant solution, and afterwards with dry wool, the precaution being taken afterwards to burn the wool. This procedure may not be called for in all cases, but in some, notably enteric fever, its importance is obvious.

Brushes, combs, and tooth brushes should be considered as infected articles and treated accordingly. When the hair is cut the clippings should be burnt.

As regards the attendants on the sick, but little need be added to what has already been said. Scrupulous cleanliness is the chief consideration, but the hands should be frequently washed in disinfectant solutions, and after bathing the surface of the body sponged with corrosive sublimate solution 1 to 1,000, or izal 1 to 200. The occasional use of antiseptic mouth washes may perhaps in certain cases reasonably be recommended.

In conclusion, it may be said that if it were necessary to summarise the main points relating to practical disinfection in the fewest possible words, without references to alternative methods or a choice of different disinfectants, an extremely concise but reasonably safe statement would, in my opinion, be as follows:—

For rooms and for furniture, books, boots, shoes, and articles liable to be injured by steam disinfection, formic aldehyde vapour, preferably Lingner's (glycoformal) apparatus, one apparatus for a room 2,800 cubic feet, 2 litres of glycoformal being used. Duration of exposure, four hours.

For general washing purposes, corrosive sublimate 1 in 1,000 (L.G.B. formula, B. W. and Co.'s soloids, one soloid to each pint of water).

For excreta, sputum, vomited matters, corrosive sublimate 1 to 500 (L.G.B. formula, B. W. and Co.'s soloids, two soloids to each pint). Duration of contact one hour. The mixture to be thorough.

For linen, cups, saucers, plates, spoons, and knives, boiling water.

For bedding, clothes, hangings, carpets, and under garments (other than linen), saturated steam at 115° C. for thirty minutes.

APPENDIX A.

GIVING THE SUMMARY FROM DR. H. F. PARSON'S REPORT ON DISINFECTION BY HEAT.[30]

1. With the exception of spore-bearing cultivations of the bacillus of anthrax, all the infective materials experimented on were destroyed by an hour's exposure to dry heat of 220° F. or five minutes' exposure to steam at 212° F. Spores of bacillus anthrax required for destruction four hours' exposure to dry heat at 220° F., but were destroyed by a five minutes' exposure to a heat of 212° F., in steam or boiling water.

It may be assumed that the contagia of the ordinary infectious diseases of mankind are not likely to withstand an exposure of an hour to dry heat of 220° F., or one of five minutes to boiling water or steam of 212° F.

2. Dry heat penetrates very slowly into bulky and badly conducting articles, such as bedding and clothing ; the time commonly allowed

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for the disinfection of such articles being insufficient to allow of an adequate degree of heat to penetrate into the interior.

Steam penetrates far more rapidly than dry heat, and its penetration may be aided by employing it under pressure, the pressure being relaxed from time to time, so as to displace the cold air in the interstices of the material.

In hot air the penetration of heat is aided by the admixture of steam, so as to moisten the air, but hot moist air did not appear to have a greater destructive effect upon the spores of anthrax bacilli than dry heat.

3. Scorching begins to occur at different temperatures with different materials, white wool being soonest affected. It is especially apt to occur where the heat is in the radiant form. To avoid risk of scorching, the heat should not be allowed much to exceed 250° F., and even this temperature is too high for white woollen articles.

4. By a heat of 212° F. and upwards, whether dry or moist, many kinds of stains are fixed in fabrics so that they will not wash out. This is a serious obstacle in the way of the employment of heat for the disinfection previous to the washing of linen, etc., soiled by the discharges of the sick.

5. Steam disinfection is inapplicable in the case of leather, or of articles which will not bear wetting. It causes a certain amount of shrinkage in textile materials, about as much as ordinary washing. The wetting effect of the steam may be diminished by surrounding the chamber with a jacket containing steam at a higher pressure, so as to superheat the steam in the chamber.

6. For articles that will stand it, washing in boiling water (with due precautions against re-infection) may be relied on as an efficient means of disinfection. It is necessary, however, that the grosser dirt should be removed by a preliminary soaking in cold water. This should be done before the linen leaves the infected place.

7. The objects for which disinfection by dry heat or steam is especially applicable are such as will not bear boiling in water—*e.g.* bedding, blankets, carpets, and cloth clothes generally.

8. The most important requisites for a good apparatus for disinfection by heat are (*a*) that the temperature in the interior shall be uniformly distributed; (*b*) that it shall be capable of being maintained constant for the time during which the operation extends; and (*c*)

that there shall be some trustworthy indication to the actual temperature of the interior at any given moment. Unless these conditions be fulfilled, there is risk on the one hand that articles exposed to heat may be scorched, or, on the other hand, through anxiety to avoid such an accident, the opposite error may be incurred, and that the articles may not be sufficiently heated to ensure their disinfection.

9. In dry heat chambers the requirement is often very far from being fulfilled, the temperature in different parts of the chamber varying sometimes by as much as 100°. This is especially the case in apparatus heated by direct application of heat to the floor or sides of the chamber. The distribution of temperature is more uniform in proportion as the source of heat is removed from the chamber, so that the latter is heated by currents of hot air rather than by radiation.

10. In chambers heated by gas, when once the required temperature has been attained, but little attention is necessary to maintain it uniform, and in the best made apparatus this is automatically performed by a thermo-regulator. On the other hand, in apparatus heated by coal or coke the temperature continually tends to vary, and can only be maintained uniform by constant attention on the part of the stoker.

11. In very few hot-air chambers did the thermometer with which the apparatus was provided afford a trustworthy indication of the temperature of the interior; in some instances there was an error of as much as 100° F. This is due to the thermometer, for reasons of safety and accessibility, being placed in the coolest part of the chamber, and to the bulb being enclosed in a metal tube, which screens it from the full access of heat. The difficulty may be overcome by using, instead of a thermometer, a pyrometer actuated by a metal rod extending across the interior of the chamber.

12. In steam apparatus the three requirements above mentioned are all satisfactorily met, and for this reason, as well as on account of the greater rapidity and certainty of action of steam, steam chambers are, in my opinion, greatly preferable to those in which dry heat is employed.

13. Without wishing to give the preference to one maker over another, I may mention that of the apparatus heated by coal, Bradford's newer machine; of those heated by gas, the Nottingham self-regulating disinfecting apparatus; and of those employing steam,

Lyon's patent steam disinfector, in my experiments, gave the best results of any in their respective classes.

14. It is important that the arrangement of the apparatus, the method of working, and the mode of conveyance to and fro should be such as to obviate risk of articles which have been submitted to disinfection coming into contact with others which are infected.

APPENDIX B.

GIVING THE GENERAL CONCLUSIONS ARRIVED AT BY THE COMMITTEE ON DISINFECTANTS OF THE AMERICAN PUBLIC HEALTH ASSOCIATION (APPOINTED IN 1884; REPORTED IN 1887).[31]

Infectious material of sporing sort.

1. Fire. Complete destruction by burning.
2. Steam under pressure. 105° C. for ten minutes.
3. Boiling in water for ½-hour.
4. Chloride of lime, a 4% solution. (Should contain at least 25% av. Cl.)
5. Mercuric chloride 1 in 500.

Infectious material of non-sporing sort.

1. Fire. Complete destruction by burning.
2. Boiling in water for ten minutes.
3. Dry heat 110° C. for 2 hours.
4. Chloride of lime, a 2% solution. (Should contain at least 25% av. Cl.)
5. Solution of chlorinated soda, 10% solution. (Should contain at least 3% av. Cl.)
6. Mercuric chloride solution, 1 in 2,000.
7. Carbolic acid, 5% solution.
8. Sulphate of copper, 5% solution.
9. Chloride of zinc, 10% solution.
10. Sulphur dioxide. Exposure for at least 12 hours to an atmosphere containing at least 4 vols. % of this gas in presence of moisture. (3–4 lbs. sulphur per 1,000 cub. ft. of air.)

FOR EXCRETA.

(a) *In the Sick Room.*

1. Chloride of lime in solution, 4%.

In the absence of spores :—

2. Carbolic acid in solution, 5%.

3. Sulphate of copper in solution, 5%.

(b) *In privy vaults.*

1. Mercuric chloride in solution, 1 in 500.

2. Carbolic acid in solution, 5%.

(c) *For the disinfection and deodorisation of masses of organic material in privy vaults, etc.*

Chloride of lime in powder.

FOR CLOTHING, BEDDING, ETC.

(a) *Soiled underclothing, bed linen, etc.*

1. Destruction by fire, if of little value.

2. Boiling for at least ½-hour.

3. Immersion in a solution of mercuric chloride of the strength of 1 in 2,000 for four hours.

4. Immersion in a 2% solution of carbolic acid for four hours.

(b) *Outer garments of wool or silk and similar articles, which would be injured by immersion in boiling water or in a disinfecting solution.*

1. Exposure in a suitable apparatus to a current of steam for 10 minutes.

2. Exposure to dry heat at a temperature of 110° C. for 2 hours.

(c) *Mattresses and blankets soiled by the discharges of the sick.*

1. Destruction by fire.

2. Exposure to superheated steam, 105° C., for 10 minutes. Mattresses to have the cover removed or freely opened.

3. Immersion in boiling water for ½-hour.

FURNITURE AND ARTICLES OF WOOD, LEATHER, AND PORCELAIN.

Washing several times repeated with—

1. Solution of carbolic acid, 2%.

FOR THE PERSON.

The hands and general surface of the body of attendants of the sick, and of convalescents, should be washed with—

1. Solution of chlorinated soda diluted with 9 parts of water, 1 in 10.
2. Carbolic acid, 2% solution.
3. Mercuric chloride, 1 in 1,000.

FOR THE DEAD.

Envelope the body in a sheet thoroughly saturated with—

1. Chloride of lime in solution, 4%.
2. Mercuric chloride in solution, 1 in 500.
3. Carbolic acid in solution, 5%.

FOR THE SICK ROOM AND HOSPITAL WARDS.

(*a*) While occupied wash all surfaces with—

1. Mercuric chloride, 1 in 1,000, in solution.
2. Carbolic acid in solution, 2%.

(*b*) When vacated, fumigate with sulphur dioxide for 12 hours, burning at least 3 lbs. of sulphur for every 1,000 cubic feet of air space in the room; then wash all surfaces with one of the above-mentioned disinfecting solutions, and afterwards with soap and hot water; finally, throw open doors and windows and ventilate freely.

[Here follow directions for disinfecting merchandise and mails, rags, ships, and railway cars, which need not here be dealt with.]

APPENDIX C.

GIVING THE RESULTS OBTAINED BY DRS. KLEIN, GORDON, AND HOUSTON IN THEIR EXPERIMENTS ON DISINFECTION.[32]

The following is a brief summary of the results shown in Table I. :—

B. typhosus: *Negative results:* Milk and gelatine emulsions on wood, cloth, linen, paper, *formalin* vapour. Broth emulsion on linen and paper, *formalin* vapour. Broth and milk emulsion on all materials, *sulphurous acid gas.* Gelatine emulsion on all materials, *carbolic acid, corrosive sublimate, bleaching powder* (24 hours). Gelatine emulsion on linen and paper, *bleaching powder* (1 hour).

Positive results: Broth emulsion on wood and cloth, *formalin* vapour (this was our first experiment; the results of further experiments which, with more resistant microbes, yielded negative results, lead one to believe that the viability of B. typhosus would be apt to be the exception rather than the rule). Gelatine emulsion on all materials,

TABLE I.

Nature of Microbe.	Nature of Emulsion applied to Material.				Nature of Materials inoculated with Emulsion of Microbes.				Nature of Disinfectant.								Result, as regards vitality of Microbe after exposure to Disinfectant. [+ = Positive Result. – = Negative Result as regards proof of viability of Microbe.]
									Gaseous.		Fluid.						
	Broth.	Milk.	Gelatine.	Sputum.	Wood.	Cloth.	Linen.	Paper.	Formalin, 30 tablets (5 hours). C. cap. 1,344 ft.	Sulphurous Acid Gas. Sulphur, 3½ lbs. (24 hours). C. cap. 1,075 ft.	Carbolic Acid, 5 p. c. (24 hours).	Condy's Fluid. (24 hrs.) Teaspoonfuls per pint. 1	Condy's Fluid. (24 hrs.) Teaspoonfuls per pint. 5	Corro. Sublimate 1 : 1000 (24 hrs).	Bleaching Powder. 1 per cent. 1 hr.	Bleaching Powder. 1 per cent. 24 hrs	
B. typhosus.	+ + + +	+ +	+		+ + + + + + +	+ + + + + +	+ + + + + +	+ + + + + +	+ + +	+	+	+		+	+	+	+ + + – + + + –
Diphtheria bacillus.	+	+ +	+ +		+ +	+ +	+ +	+ +	+	+							– –
B. pyocyaneus.	+	+ +	+		+ + + + + +	+ + + + + +	+ + + + + +	+ + + + + +	+	+	+	+	+	+	+ +	+ +	– – – + + –
Cholera vibrio.	+	+ +	+		+ + + + + +	+ + + + + +	+ + + + + +	+ + + + + +	+	+	+	+	+	+	+ +	+ +	– – – + + + –
Staphylococcus pyogenes aureus.	+ +	+	+		+ + + + + +	+ + + + + +	+ + + + + +	+ + + + + +	+	+	+	+	+	+	+ +	+ +	– – + + + + + +
Spores of B. anthracis.	+ +	+ + + +	+		+ + + + + +	+ + + + + +	+ + + + + +	+ + + + + +	+ +	+ + + +	+	+	+	+	+ +	+ +	+ + + + + + +
Tubercle bacillus.				+ + + + + +	+ + + + + +	+ + + + + +	+ + + + + +	+ + + + + +	+ +	+	+	+	+	+	+ +	+ +	+ + + + + + +

Condy's fluid. Gelatine emulsion on wood and cloth, *bleaching powder* (1 hour).

B. diphtheriæ: *Negative results:* Milk and gelatine emulsions as regards *formalin* vapour, and broth, milk, and gelatine emulsions in respect of *sulphurous acid gas*, on all materials (wood, cloth, linen, paper).

B. pyocyaneus: *Negative results:* Milk and gelatine emulsions on all materials *formalin*, and broth and milk emulsions *sulphurous acid gas*. Gelatine emulsion on wood, cloth, linen, paper, *carbolic acid* and *corrosive sublimate*. Gelatine emulsion on wood, linen, and paper, *bleaching powder* both strengths.

Positive results: Gelatine emulsion on all materials, *Condy's fluid*. Gelatine emulsion on cloth, *bleaching powder*.

Cholera Vibrio: *Negative results:* Milk and gelatine emulsions as regards *formalin*, and in broth, milk, and gelatine emulsions in respect of *sulphurous acid gas*, on all materials. Gelatine emulsion on wood, cloth, linen, paper, *carbolic acid*, *corrosive sublimate*, and *bleaching powder* (24 hours). Gelatine emulsion on linen, *Condy's fluid* (strong solution). Gelatine emulsion on wood, linen, and paper *bleaching powder* (1 hour).

Positive results: Gelatine emulsion on all materials, *Condy's fluid* (weak solution), and on wood, cloth, and paper, *Condy's fluid* (strong solution). Gelatine emulsion on cloth, *bleaching powder* (1 hour).

Staph. p. aureus: *Negative results:* Broth emulsion on all materials, *formalin*. Broth and milk emulsion on wood, cloth, linen, and paper, *sulphurous acid gas*. Gelatine emulsion on all materials, *carbolic acid*. Gelatine emulsion on linen, *Condy's fluid* (strong solution). Gelatine emulsion on all materials, *corrosive sublimate*. Gelatine emulsion on linen and paper, *bleaching powder* (1 hour). Gelatine emulsion on wood, cloth, and paper, *bleaching powder* (24 hours).

Positive results: Gelatine emulsion on all materials, *Condy's fluid* (weak solution). Gelatine emulsion on wood, cloth, and paper, *Condy's fluid* (strong solution). Gelatine emulsion on wood and cloth 1 hour's contact, and on linen 24 hours' exposure, *bleaching powder*.

Spores of B. anthracis: *Negative results:* Milk emulsion on linen, *formalin*. Broth emulsion on cloth, linen, and paper, and milk emulsion on linen and paper, *sulphurous acid gas*. Gelatine emulsion on all materials, *corrosive sublimate*. Gelatine emulsion on linen and paper (1 hour) and on paper only (24 hours), *bleaching powder*.

TABLE II.

Nature of Disinfectant.	*Nature of Emulsion applied to Material.*				*Nature of Materials inoculated with Emulsion of Microbes.*				*Nature of Microbe.*								*Result as regards vitality of Micro'e after exposure to Disinfectant.* [+ = *Positive Result.* − = *Negative Result as regards proof of viability of Microbe.*]
	Broth.	*Milk.*	*Gelatine.*	*Sputum.*	*Wood.*	*Cloth.*	*Linen.*	*Paper.*	*B. typhosus.*	*Diphtheria bacillus.*	*B. pyocyaneus.*	*Cholera vibrio.*	*Staphylococcus pyogenes aureus.*	*Spores of B. anthracis.*	*Tubercle bacillus.*		
Formalin (30 tablets), 5 hours, cubic capacity 1,344 ft.	+	+	+		+	+	+	+	+	+	+	+					−
	+				+	+		+	+								+
	+						+	+	+								−
		+			+	+	+	+					+				+
		+			+	+		+						+			−
				+			+							+			−
				+	+	+								+			−
							+	+							+		−
Sulphur dioxide, Sulphur, 3½ lbs. 24 hours, cubic capacity, 1,075 ft.	+	+			+	+	+	+	+				+				−
	+	+	+		+	+	+	+		+		+					−
	+	+			+	+	+	+			+						−
	+				+	+								+			−
		+				+	+	+						+			−
		+			+	+								+			−
				+	+	+	+	+							+		+
Carbolic acid, 5 per cent., 24 hours.			+		+	+	+	+	+	...	+	+	+				−
			+		+	+	+	+						+			+
				+	+	+	+	+							+		−
Condy's Fluid, teaspoonfuls per pint, 24 hours. 1			+		+	+	+	+	+	...	+	+	+	+			+
				+	+	+	+	+							+		+
5			+		+	+	+	+	+	...	+			+			+
			+		+	+		+				+	+				+
			+	+	+	+	+					+	+				+
				+			+								+		+
				+			+								+		+
Corrosive sublimate, 1 : 1000, 24 hours.			+		+	+	+	+	+	...	+	+	+	+			−
				+	+	+	+	+							+		−
Bleaching powder, 1 per cent. solution. 1 hour.			+		+	+			+	...			+	+			+
			+		+	+	+	+	+				+	+			−
			+				+	+			+	+					+
			+	+	+						+				+		−
				+		+	+	+							+		−
24 hours.			+		+	+	+	+	+	...		+					+
			+				+	+			+		+				−
			+		+	+	+						+				+
			+					+						+			+
			+	+	+	+	+	+						+			−
				+		+									+		+
				+	+		+	+							+		−

Positive results : Milk emulsion on wood, cloth, and paper, *formalin.* Broth emulsion on wood and milk emulsion on wood and cloth, *sulphurous acid gas.* Gelatine emulsion on all materials, *Condy's fluid* (both strengths) and *carbolic acid.* Gelatine emulsion on wood and cloth (1 hour), and on wood, cloth, and linen (24 hours), *bleaching powder.*

Tubercle bacillus : *Negative results :* Sputum on linen and paper, *formalin* and *bleaching powder* (1 hour) ; on all materials, *carbolic acid* and *corrosive sublimate ;* on linen, *Condy's fluid* (strong) ; on wood, linen and paper, *bleaching powder* (24 hours).

Positive results : Sputum on wood and cloth, *formalin* and *bleaching powder* (1 hour) ; on all materials, *sulphurous acid gas* and *Condy's fluid* (weak) ; on wood, cloth, and paper, *Condy's fluid* (strong) ; on cloth, *bleaching powder* (24 hours).

The following is a brief summary of the results shown in Table II. :—

Formalin (30 tablets), 5 hours ; cubic capacity of room, 1,344 feet. *Negative results :* Milk and gelatine emulsion on all materials, *B. typhosus, diphtheria bacillus, B. pyocyaneus, cholera vibrio.* Broth emulsion on linen and paper, *B. typhosus.* Broth emulsion on all materials, *Staph p. aureus.* Milk emulsion on linen, *spores of B. anthracis.* Sputum on linen and paper, *tubercle bacillus.*

Positive results : Broth emulsion on wood and cloth, *B. typhosus.* Milk emulsion on wood, cloth, and paper, *spores of B. anthracis.* Sputum on wood, and cloth, *tubercle bacillus.*

Sulphur dioxide.—Sulphur, $3\frac{1}{2}$ lbs., 24 hours ; cubic capacity of room, 1,075 feet. *Negative results :* Broth and milk emulsion on all materials, *B. typhosus* and *Staph. pyogenes aureus.* Broth, milk, and gelatine emulsions on all materials, *diphtheria bacillus* and *cholera vibrio.* Broth and milk emulsions on all materials, *B. pyocyaneus.* Broth emulsion on cloth, linen and paper, spores of *B. anthracis.* Milk emulsion on linen and paper, spores of *B. anthracis.*

Positive results : Broth emulsion on wood, spores of *B. anthracis.* Milk emulsion on wood and cloth, spores of *B. anthracis.* Sputum, on all materials, *tubercle bacillus.*

Carbolic acid, 5%, 24 hours. *Negative results :* Gelatine emulsion on all materials, *B. typhosus, B. pyocyaneus, cholera vibrio, Staph. p. aureus.* Sputum on all materials, *tubercle bacillus. Positive results :* Gelatine emulsion on all materials, spores of *B. anthracis.*

Condy's fluid: 1 teaspoonful per pint, 24 hours' contact. *Negative results:* None.

Positive results: Gelatine emulsion on all materials, *B. typhosus, B. pyocyaneus, cholera vibrio, staph. p. aureus, spores of B. anthracis:* Sputum on all materials, *tubercle bacillus.*

Five teaspoonfuls per pint, 24 hours' contact. *Negative results:* Gelatine emulsion on linen, *cholera vibrio* and *staph. p. aureus.* Sputum on linen, *tubercle bacillus.*

Positive results: Gelatine emulsion on all materials, *B. typhosus, B. pyocyaneus,* and *spores of B. anthracis.* Gelatine emulsion on wood, cloth, and paper, *cholera vibrio* and *staph. p. aureus.* Sputum on wood, cloth, and paper, *tubercle bacillus.*

Corrosive sublimate: 1 : 1000, 24 hours' contact. *Negative results:* Gelatine emulsion on all materials, *B. typhosus, B. pyocyaneus, cholera vibrio, staph. p. aureus, spores of B. anthracis.* Sputum on all materials, *tubercle bacillus.*

Positive results: None.

Bleaching powder: 1 : 100, 1 hour contact. *Negative results:* Gelatine emulsion on linen and paper, *B. typhosus, staph. p. aureus, spores of B. anthracis.* Gelatine emulsion on wood, linen, and paper. *B. pyocyaneus* and *cholera vibrio.* Sputum on linen and paper, *tubercle bacillus.*

Positive results: Gelatine emulsion on wood and cloth, *B. typhosus, staph. p. aureus,* and *spores of B. anthracis.* Gelatine emulsion on cloth, *B. pyocyaneus* and *cholera vibrio.* Sputum on cloth and wood, *tubercle bacillus.*

1 : 100, 24 hours' contact. *Negative results:* Gelatine emulsion on all materials, *B. typhosus* and *cholera vibrio.* Gelatine emulsion on wood, linen, and paper, *B. pyocyaneus.* Gelatine emulsion on wood, cloth, and paper, *staph. p. aureus.* Gelatine emulsion on paper, spores of *B. anthracis.* Sputum on wood, linen, and paper, *tubercle bacillus.*

Positive results: Gelatine emulsion on cloth, *B. pyocyaneus.* Gelatine emulsion on linen, *staph. p. aureus.* Gelatine emulsion on wood, cloth, and linen, *spores of B. anthracis.* Sputum on cloth, *tubercle bacillus.* [Although these results were good, they would doubtless have been much better if, under the conditions of our experiments, much of the available chlorine had not been used up in attacking the oxidisable matter contained in the materials themselves.]

APPENDIX D.

GIVING SOME OF THE CONCLUSIONS ARRIVED AT BY DR. KENWOOD AS A RESULT OF HIS EXPERIMENTS ON DISINFECTION OF ROOMS BY SULPHUROUS ACID GAS AND FORMIC ALDEHYDE VAPOURS.

Dr. H. R. Kenwood, in a paper on Disinfection by Formic Aldehyde Vapours, states :—[33]

" 1. That when the atmosphere is charged with less than 1% of the vapour, the disinfection of all surfaces is complete and rapid, and that this holds good under the ordinary conditions of temperature and moisture obtaining in living rooms.

" 2. That the vapours possess a certain and variable amount of penetrating power into loose fabrics, especially when these are dry. This penetration is largely due to the circumstance that when produced in a warm state the vapour is of a low specific gravity, and mixes well with the air.

" (These facts have been proved by numerous experiments by different workers, in which the following objects were exposed :—The specific organisms of cholera, diphtheria, enteric, tetanus, and tuberculosis ; B. coli communis, B. anthracis with spores, Tricophyton spores, Staph. pyogen. aureus, phthisical sputum, dust, soil, etc.)

" 3. That the vapours do not affect the colours of textile materials, etc., or, with the exception of iron and steel, metallic surfaces.

" 4. That the room and articles exposed can be cleared of the vapours readily by efficient aëration, and the vapours are not so irritating but one can always enter the room and unseal at the first attempt (an advantage over SO_2 and Cl_2).

" 5. That the disinfecting properties of the aldehyde are greater than those of SO_2 or Cl_2.

" 6. That there is no danger in entering the room, either from the aldehyde, or from the CO which is formed at the same time. This is proved from the fact that the men employed at the works and exposed to considerable quantities enjoy good health, and also from many experiments with animals in atmospheres heavily charged with the vapours generated, as in room disinfection."[1]

Dr. Kenwood, in a previous communication on the Disinfection of Rooms by Sulphurous Acid Gas (*British Medical Journal*, August, 1896), states that in his experience SO_2 ½% kills the diphtheria bacillus,

and that gaseous disinfection of rooms with SO_2 is to be preferred to the spraying by hand of disinfecting solution, or to rubbing the walls according to the Continental method with bread.

APPENDIX E.

GIVING THE CONCLUSIONS ARRIVED AT BY PROFESSOR SHERIDAN DÉLÉPINE AS A RESULT OF HIS EXPERIMENTS ON THE DISINFECTION OF ROOMS BY GASEOUS FORMALDEHYDE.[34]

"1. With unimportant exceptions, the *bacillus coli communis*, *bacillus pyocyaneus*, *bacillus tuberculosis*, and *staphylococcus pyogenes aureus* were killed whether in the dry or moist state, even when placed in deep, narrow recesses two inches from the opening of tubes open at only one end or protected by one to three layers of filter paper, or imbedded in a thick layer of sputum.

"2. The *spores of bacillus anthracis* were killed in twelve experiments out of nineteen, made under conditions not favourable to the access of the gas. The differences in the results seem to have been due more to certain states of the spores than to variability in the action of formic aldehyde.

"3. The action on *spores of bacillus subtilis* was uncertain. The very highly resisting spores of a horse-manure bacillus, resembling the hay bacillus, could not be killed by exposures of a practical duration. The only evidence of action was a distinct delay in their growth.

"Sulphurous acid, vapours of phenol, of cresol, of izal, dry chlorine, have all been tried in my laboratory under the same experimental conditions as those described above; have given me results inferior to those obtained with formic aldehyde gas.

"Its powers of diffusion are considerable, so that it can easily penetrate into recesses which offer serious barriers to most of the other gaseous disinfectants. The irregularities of action which I have observed are very slight compared with those occurring with other disinfecting gases.

"Fabrics made of various materials are quite unaffected by the gas, and very few colours are altered by it, and that to a slight extent only.

"It is quite evident that formaldehyde is the best gaseous disinfectant we possess at the present time for objects which are liable to be damaged by damp, chlorine, dry and moist heat."[34]

APPENDIX F.

GIVING SOME OF THE CONCLUSIONS ARRIVED AT BY VARIOUS AUTHORITIES WHO HAVE PRACTICALLY TESTED LINGNER'S DISINFECTING APPARATUS (GLYCOFORMAL).

It was found by Dr. Klein that in a room of 683 cub. ft. capacity three hours' exposure to formaldehyde distributed in a closed (sealed up) room by the Lingner apparatus was successful in completely disinfecting virulent spores of bacillus anthracis and virulent tubercular sputum.

At the Royal Institute of Infectious Diseases in Berlin (Professor Koch), it was found that the glycoformal apparatus has been wrongly regarded with suspicion, owing to the belief that the strong development of vapour would exercise a detrimental effect on furniture, clothes, leathers, etc. On the occasion of many experiments articles of the most various kinds were placed in the room to be disinfected, but no alteration deserving of mention in any of the objects was discoverable.

It was further found from experiment in a small room, of which the doors and windows were closed merely in the ordinary manner, that, working the apparatus for 1½ hours, anthrax bacilli in an open drawer and behind a stove, staphl. pyogenes on a stove, enclosed in a cupboard, and inserted under a cupboard, were killed ; fæces were sterilised on a shelf, but not in the pocket of a coat.

Under the auspices of the Imperial Institute for Experimental Medicine, St. Petersburg, it was concluded by Dr. S. K. Dzierzgowski that Lingner's disinfecting apparatus must, on account of its disinfecting power, be ranked above all other known apparatus which disinfect with formalin.

Further, when, in August, 1899, Dr Dzierzgowski was engaged in combating an outbreak of bubonic plague at the village of Kolobovka in the Government of Astrachan, he found with regard to the use of formaldehyde solution (glycoformal) for disinfecting dwelling rooms, and with special regard to its effect on the bacillus of bubonic plague, that it is extremely effective, and absolutely to be relied upon to kill the organism in question. The same authority also states that the glycoformal spray diffused by Lingner's apparatus settles firmly on the superficies of the room that is to be disinfected, and upon the

superficies of the objects contained in it, thus covering them with a concentrated formalin solution, which destroys the infection.

Dr. Dzierzgowski carried out 315 disinfections of rooms and their contents with glycoformal.

Dr. Stuart Eldridge, of the U.S. Marine Hospital at Yokohama (Japan), states that for the disinfection of the clothes and luggage of emigrants the Lingner apparatus has given him absolute satisfaction ; he finds it completely effective and simple to manipulate even for inexperienced persons.

Professor Escherich, of Gratz, found Lingner's apparatus satisfactory for the destruction of human parasites.

The following authorities state that with regard to formalin disinfection their best results were obtained with Lingner's apparatus : Dr. Pfuhl, of Hanover ; Professor Nowack, of Dresden ; the Vienna Hygienic Institute ; Professor Belfanti, of Milan ; Drs. Ajtai K. Sandor Jstvan and Krausz, of Buda-Pesth.

Drs. Newman and Houston obtained the following results :—

First series of experiments :—

Capacity of room, 3,153 cubic feet. Two litres of glycoformal were used. Duration of exposure, 4 hours. The room was securely sealed up in the usual way. May 29th, 1902.

A. Four small conical flasks were placed on a shelf 5 feet from the ground and 10 feet from the apparatus. Their contents were as follows :—

(a) 1 *gramme dried horse manure.*
(b) 1 *gramme moist horse manure.*
(c) 1 *gramme dried garden soil.*
(d) 1 *gramme moist garden soil.*

The cotton-wool plugs were removed just before the experiment commenced, and replaced at its conclusion. The flasks were subsequently examined as follows : To each flask was added 10 c.c. of broth, and, after shaking for some time, loopfuls of the mixture were transferred to a number of broth tubes. The flasks and broth tubes were incubated at blood heat.

The test proved too severe, as in each case a growth occurred of the highly resistant sporing microbes of soil and manure.

B. Four test tubes, 6″ by $\frac{3}{4}$″, were laid horizontally on the same shelf. Their contents were as follows :—

(a) *A camel's hair brush steeped in a strong solution of B. pyocyaneus from an agar culture, allowed to become nearly, if not quite, air-dry, and placed brush end downwards in the test tube.*

(b) *As above, but a culture of Staph. pyogenes aureus used.*

(c) *As above, but a culture of B. coli used.*

(d) *As above, but the brush steeped in crude sewage.*

The cotton-wool plugs were removed just before the experiment commenced, and replaced at its conclusion. The subsequent procedure was as follows : Each brush was transferred to a tube containing 10 c.c. of sterile broth, and after steeping in the broth for some time, used to brush over the surface of agar previously set in a series of Petri's capsules. The cultures were incubated at blood heat.

The test again proved too severe, as in each case a growth occurred of respectively B. pyocyaneus, S. p. aureus, B. coli, and sewage microbes. It may be surmised that the formalin killed the microbes attached to the outer fibres of the brush, but failed to reach the germs concealed in the central portion.

Second series of experiments :—

Capacity of room, 1,336 *cubic feet. About* 1,330 *c.c. of glycoformal were used. Duration of exposure,* 4 *hours. The room was sealed up in the usual way. June 5th,* 1902.

1. Eight 4-ounce wide-mouthed and glass-stoppered bottles were placed on a chair 8 feet from the apparatus. Their contents were as follows :—

B. pyocyaneus:

(a) *Wood, unvarnished, steeped in a strong emulsion of B. pyocyaneus from an agar culture and allowed to become nearly, if not quite, air dry.*

(b) *As above, but cloth used.*

(c) *As above, but linen used.*

(d) *As above, but paper used.*

Staph. p. aureus.

(a′) *Wood, unvarnished, steeped in a strong emulsion of Staph. pyogenes aureus from an agar culture, and allowed to become nearly, if not quite, air dry.*

(b′) *As above, but cloth used.*

(c′) *As above, but linen used.*

(d′) *As above, but paper used.*

The stoppers were removed just before the experiment commenced, and replaced at its conclusion. The subsequent procedure was as

follows : To each bottle was added 10 c.c. of broth, and, after prolonged shaking, loopfuls of the liquid were transferred to the surface of a series of oblique agar tubes. The bottles and agar tubes were incubated at blood heat. Control experiments were carried out in the laboratory on exactly the same lines.

The results were very satisfactory, as the control experiments yielded B. pyocyaneus and s. p. aureus on all the materials, whereas none of the materials exposed to the formalin vapour gave any growth. Moreover, the control experiments yielded cultures not only of B. pyocyaneus and s. p. aureus, but also of sporing microbes and moulds. It may, therefore, be concluded that the formalin had destroyed the saprophytic bacteria originally present in the materials (wood, cloth, linen, and paper), as well as the pathogenic microbes artificially added.

We found that a leather-bound book and a leather-seated chair were not injured in any way whatever.

It should be added that as far as practicable the directions for using the apparatus were followed. These directions include the standard of "two litres of disinfecting fluid" (glycoformal) for rooms up to 2,800 cubic feet. The first series of experiments was therefore carried out in a room having 350 feet cubic space *in excess* of 2,800. This fact must be taken into consideration in the interpretation placed upon the results.

"For smaller rooms (than 2,800 cubic feet) the amount of disinfecting fluid must not be reduced simply in arithmetical proportion to the cubical contents, as a room which is smaller than 2,800 cubic feet nevertheless presents comparatively more surface, and therefore requires a comparatively larger amount of the disinfectant. The quantity of disinfecting fluid must, therefore, only be reduced in ratio to the surface to be disinfected."

In accordance with these directions, we used in the second series, for a room of 1,336 cubic feet, 1,330 c.c. of glycoformal instead of 2,000 c.c.

APPENDIX G.

GIVING THE CONCLUSIONS ARRIVED AT BY PROFESSOR SHERIDAN DÉLÉPINE AND DR. ARTHUR RANSOME AS THE RESULT OF THEIR EXPERIMENTS ON THE DISINFECTION OF TUBERCLE INFECTED HOUSES.[35]

Putting aside the numerous experiments which have been made for the purpose of testing (1) the virulence of tuberculous products

used in the experiments ; (2) the influence of collateral factors such as ventilation, dryness, heat, etc., we may sum up the results obtained in the following way :—

1. The disinfection of rooms which have been contaminated with tuberculous products cannot be obtained by means of the fumigation methods such as are generally used at present. Sulphurous acid, chlorine, and euchlorine, as used under supervision by experienced municipal disinfectors, have proved practically useless. This only confirms the results obtained by Koch and his pupils in the case of a number of other organisms.

2. The only other method of disinfection which seemed to promise more satisfactory results was the direct application of a solution of chlorinated lime (S. Délépine, On the Disinfection of Rooms ; *Med. Chronicle*, May, 1894) to the walls to be disinfected. This method has so far given satisfactory results, but it is attended with discomfort on the part of those who have to carry out the disinfection.[36] It must be remembered that the experiments of Schill and Fischer are unfavourable to the use of perchloride of mercury.

3. Light is in the case of the tubercle bacillus, as it has been proved by several observers to be in the case of other organisms, the most important natural disinfecting agent.

APPENDIX H.

GIVING THE CONCLUSIONS ARRIVED AT BY PROFESSOR SHERIDAN DÉLÉPINE AS A RESULT OF HIS EXPERIMENTS ON DISINFECTION BY RAPID CURRENTS OF SATURATED STEAM AT LOW PRESSURE, AND WITH A NEW FORM OF STEAM DISINFECTOR.[37]

"It can, however, safely be said that *for sanitary purposes efficient disinfection can be obtained in fifteen minutes* by current steam at 103° or 104° C."

"Without denying the power which saturated steam under high pressure has to kill the most resisting spores in a shorter time than current saturated steam at low pressure can, I think it must be admitted that current steam, properly used, has great penetrating powers, and kills readily the most resisting pathogenic organisms which are known to affect man. I have also shown that by a simple arrangement a current steam disinfector can be made to act as a good drying chamber."

APPENDIX I.

GIVING THE RESULTS OF EXPERIMENTS ON THE DISINFECTION OF THE EXCRETA BY DRS. C. A. HILL AND J. H. ABRAM.[38]

TABLE I.

Disinfectant.	*Strength.*	Action on Fæces.	
		When Mixed.	*When Unmixed.*
Perchloride of mercury..	1 in 1,000	Spore-bearing forms	Copious growth
Formol	1 in 20	Sterile	Copious
Carbolic acid	1 in 20	Sterile	Copious
Iodic hydrarg.	1 in 4,000	Spore-bearing forms	Copious
Chloros	Undiluted	Limited	Limited
Chinosol	1 in 600	Sterile	Copious
Izal	1 in 200	Spore-bearing forms	—
Creolin	1 in 10	Sterile	—
Carbolic acid (crude) ..	Undiluted	Sterile	—
Zinc chloride	1 in 10	Copious growth	—
Copper sulphate.. ..	1 in 20	Copious	—
Boiling water	—	Copious	—
Sodium chloride ..	1 in 10	Copious	—
Chloride of lime, 15% Cl.	1 in 10	Copious	—
Chloride of lime, 35% Cl.	1 in 10	Considerable	—

TABLE II.

Minimum Strength of Six Solutions, with Approximate Cost per gallon.

Carbolic acid	1 in 20	1s. 0d.
Crude Carbolic	1 in 40	6d.
Formol	1 in 40	1s. 6d.
Chinosol	1 in 600	1s. 0d.
Creolin	1 in 40	1s. 6d.
Mercuric Chloride	1 in 500	9d.

The above solutions were tested with a typhoid stool, and all gave complete sterilisation.

We may sum up our paper with the following conclusion :—

1. It is absolutely necessary to mix the fæces thoroughly with the disinfectant.

2. The mixture should stand at least half an hour.

3. Carbolic acid, crude carbolic acid, formol, creolin, chinosol, and corrosive sublimate in the strengths given in the short list are all effective, but chinosol seems the most convenient.

APPENDIX J.

SHOWING THE RESULTS OF SOME EXPERIMENTS ON THE DISINFECTION OF THE EXCRETA. BY DR. A. C. HOUSTON.

The total bulk of the fæces, urine, and paper was in each case made up with a solution of the disinfectant to 2 pints. The duration of contact was one hour. The fæcal matter was mixed as thoroughly as possible with the disinfectant solution. (See Table p. 41.)

APPENDIX K.

SHOWING THE RESULTS OF SOME EXPERIMENTS ON THE DISINFECTION OF LINEN. BY DR. A. C. HOUSTON.

A linen handkerchief (19″ by 19″) was steeped in an emulsion of B. coli, obtained by transferring the whole of the growth from an oblique agar culture of B. coli into 90 c.c. of sterile water. The handkerchief was next lightly wrung out and placed in a beaker, and only 100 c.c. (just enough to cover the handkerchief) of the disinfectant added. The duration of contact was one hour, and during this period the handkerchief was occasionally moved about and turned over by means of a sterile glass rod. At the end of one hour cultures were made in broth with 1 c.c. and a loop from the contents of the beaker; subsequently, when growth occurred, subcultures from the broth were made in various media.

TABLE—APPENDIX J.

Disinfectant.	*Bulk of Fæces and Paper.*	*Amount of Urine.*	*Combined Bulk of Fæces, Urine, and Paper.*	*Proportion of Disinfectant to Combined Bulk of Fæces, Urine, Paper, and Water.*	*Results, as regards (a) Growth, (b) Extinction of B. coli; 1 c.c. Cultures in 100 c.c. Broth, and Loop Cultures in 10 c.c. Broth, with Subcultures from these on various Media.*
1. Corrosive sublimate.	5½ oz.	2½ oz.	8 oz.	1 to 1000	(*a*) Growth, (*b*) B. coli killed.
2. ,, ,,	½ oz.	½ oz.	1 oz.	1 to 500	(*a*) No growth occurred.
3. Izal, ordinary.	...	...	...	1 to 1000	(*a*) Growth, (*b*) B. coli not killed.
4. ,, ,,	3 oz.	3 oz.	6 oz.	1 to 250	,, ,, ,,
5. ,, ,,	...	...	4 oz.	1 to 100	(*a*) No growth occurred.
6. Chinosol.	...	...	6 oz.	1 to 600	(*a*) Growth, (*b*) B. coli not killed.
7. ,,	4¼ oz.	1¼ oz.	5½ oz.	1 to 300	,, ,, ,,
8. ,,	4 oz.	4 oz.	8 oz.	1 to 75	,, ,, ,,
9. ,,	1 oz.	1 oz.	2 oz.	1 to 75	,, ,, ,,
10. Carbolic acid.	6¾ oz.	1¼ oz.	8 oz.	1 to 100	(*a*) Growth, (*b*) B. coli killed.
11. ,, ,,	2¼ oz.	2¼ oz.	4½ oz.	1 to 20	(*a*) No growth occurred.
12. Copper sulphate.	4 oz.	3¼ oz.	7¼ oz.	1 to 20	(*a*) No growth.
13. ,, ,,	1¼ oz.	3¾ oz.	5 oz.	1 to 20	,, ,,
14. ,, ,,	5½ oz.	4 oz.	9½ oz.	1 to 100	(*a*) Growth, (*b*) B. coli killed.
15. Bleaching powder.	4 oz.	4 oz.	8 oz.	1 to 1000	(*a*) Growth, (*b*) B. coli killed.
16. ,, ,,	4 oz.	2¾ oz.	6¾ oz.	1 to 100	(*a*) No growth occurred.
17. ,, ,,	2½ oz.	3½ oz.	6 oz.	1 to 20	(*a*) Here growth occurred of a sporing microbe.
18. Bleaching powder and H_2SO_4.	5 oz.	2¼ oz.	7¼ oz.	1 to 200 both bl. p. and H_2SO_4.	(*a*) Growth, (*b*) B. coli killed.
19. Formalin, 40 per cent. sol. of formic aldehyde gas.	3 oz.	3 oz.	6 oz.	1 : 100	(*a*) Growth, (*b*) B. coli not killed.
20. ,, ,, ,,	4½ oz.	2 oz.	6½ oz.	1 : 20	(*a*) Growth, (*b*) B. coli killed.
21. Lysol.	4 oz.	2½ oz.	6½ oz.	1 : 100	(*a*) Growth, (*b*) B. coli killed.
22. ,,	5½ oz.	3 oz.	8½ oz.	1 : 40	,, ,, ,,
23. Cresol.	6½ oz.	2 oz.	8½ oz.	1 : 100	(*a*) Growth, (*b*) B. coli killed.
24. ,,	4½ oz.	3 oz.	7½ oz.	1 : 40	,, ,, ,,
25. Boiling water, temp. after 5 mins. 63° C.	7 oz.	2 oz.	9 oz.	water, 31 oz. stool, 9 oz.	(*a*) Growth, (*b*) B. coli killed.
26. Boiling water, temp. after 5 mins. 59° C.	5½ oz.	2½ oz.	8 oz.	water, 32 oz. stool, 8 oz.	(*a*) Growth, (*b*) B. coli not killed.
27. Boiling water, *plus* 3·2 drs. $KMnO_4$, temp. after 5 mins. 64° C.	2¼ oz.	4¼ oz.	6½ oz.	water, 33½ oz. stool, 6½ oz. $KMnO_4$, 1 per cent.	(*a*) Growth, (*b*) B. coli killed. In this expt. duration of contact only ½ hr., temp. at end of half hr. being 45° C.
28. Creolin.	5½ oz.	2 oz.	7½ oz.	1 to 100	(*a*) Growth, (*b*) B. coli not killed.
29. ,,	5½ oz.	2½ oz.	8 oz.	1 to 20	(*a*) No growth occurred.
30. ,,	7 oz.	2 oz.	9 oz.	1 to 40	(*a*) Growth, (*b*) B. coli killed.

The following is a brief account of the results obtained :—

Corrosive sublimate ..	1 to 100,000 ..	B. coli not killed.
,, ,, ..	1 to 10,000 ..	B. coli killed.
,, ,, ...	,, ,, ..	,, ,,
,, ,, ...	,, ,, ..	,, ,,
Chinosol	1 to 1,000 ..	B. coli not killed.
,, ...	1 to 500 ..	,, ,,
,, ...	1 to 250 ..	,, ,,
,, ...	1 to 250 ..	,, ,,
,, ...	1 to 250 ..	,, ,,
,, ...	1 to 150 ..	,, ,,
,, ...	1 to 125 ..	,, ,,
,, ...	1 to 62 ..	,, ,,
,, ...	1 to 62 ..	,, ,,
,, ...	1 to 62 ..	,, ,,
Ordinary Izal	1 to 1,000 ..	,, ,,
,, ,, ...	1 to 500 ..	,, ,,
,, ,, ...	1 to 250 ..	B. coli killed.
,, ,, ...	1 to 250 ..	,, ,,
,, ,, ...	1 to 250 ..	,, ,,
,, ,, ...	1 to 250 ..	,, ,,
Carbolic acid	1 to 500 ..	B. coli not killed.
,, ,, ...	1 to 100 ..	B. coli killed.
,, ,, ...	,, ,, ..	,, ,,
,, ,, ...	,, ,, ..	,, ,,
,, ,, ...	,, ,, ..	,, ,,
Chloros, sodium hypochlorite	1 to 10,000 ..	B. coli not killed.
,, ,, ..	1 to 5,000 ..	B. coli killed
,, ,, ..	,, ,, ..	B. coli not killed.
,, ,, ..	1 to 1,000 ..	B. coli killed.
,, ,, ..	,, ,, ..	,, ,,
,, ,, ..	,, ,, ..	,, ,,

100 c.c. of boiling water, temperature after 5 mins. 55° C. B. coli not killed.

200 c.c. of boiling water, temperature after 5 mins. 66° C. B. coli not killed.

300 c.c. of boiling water, temperature after 5 mins. 74° C. B. coli killed.

300 c.c. of boiling water, temperature after 5 mins. 70° C. B. coli killed.

300 c.c. of boiling water, temperature after 5 mins. 72° C. B. coli killed.

REFERENCES.

[1] Paper read before the Medical Officers of Schools Association on June 19, 1902.

[2] "Report of the Medical Officer, Local Government Board," 1884. "Appendix B., No. 10." "Report on Disinfection by Heat," by Dr. Parsons.

[3] "On Disinfection," by Dr. Russell, "Glasgow Medical Journal," 1884.

[4] "Mittheilungen aus dem K. Gesundheitsamte," 1881.

[5] "Report of the Medical Officer, London County Council." "Experiments on Disinfection by Drs. Klein, Gordon, and Houston" (1902).

[6] Dr. Joy in course of discussion made some useful remarks with regard to the relative infectivity of diseases commonly met with in school medical practice.

[7] I am not speaking here of smallpox and typhus fever, although, as regards the latter disease, it is believed that dilution of the poison affords almost complete protection.

[8] Dr. Shelly, in the discussion following the reading of the paper, drew attention to the injurious action of sulphur dioxide in connection with electric fittings.

[9] "Public Health," November, 1897.

[10] Dr. Wynter Blythe has reported favourably on this apparatus.

[11] At the discussion one of the speakers asked whether in the case of small rooms the alformant lamp might not be considered sufficiently reliable for all practical purposes. The answer made by the writer was a cautious one, but in the affirmative. A similar answer was made to Dr. Christopher Childs' question, whether the penetrative ability of formalin was greater than that of sulphurous acid gas.

[12] "Disinfection and Disinfectants," p. 332. By Dr. Rideal.

[13] Corrosive sublimate, 1 to 500; izal, 1 to 100; carbolic acid, 1 to 20.

[14] Some such procedure as this is, I believe, recommended by Dr. Clement Dukes.

[15] In the discussion following the reading of this paper Dr. Shelly laid great stress on the importance of burning all books except those of special value. As regards "measles books," his experience was that fresh air and sunshine were the best disinfectants. Dr. Shelly very properly pointed out that the recommendation of having separate shelves for different infective diseases was practically an admission of an imperfect faith in the certainty of disinfecting books.

[16] "Bacteria," by Dr. Newman, p. 371, on "Disinfection."

[17] At the discussion Dr. Christopher Childs drew attention to the fact that the Americans had of late years obtained good results with slaked lime (CaO,H_2O). He also emphasised the importance of adding hydrochloric acid as well as corrosive sublimate to the material sought to be disinfected.

[18] It should be pointed out that years ago Dr. Sternberg recommended the use of boiling water in the proportion of three or four parts to one part of the material to be disinfected.

[19] EXPERIMENT.—10 ounces of water were poured into a large glass beaker; two pints of boiling water were next added to the contents of the beaker. The temperature after 5, 10, 15, 20, 25, and 30 minutes was found to be 73.5° C, 68.5° C., 65° C., 61.5° C., 58.5° C., and 56° C., respectively.

[20] The precipitating effect of albuminous matters in relation to the germicidal action of corrosive sublimate and the weakening effect of organic matter as regards chlorine compounds must be borne in mind. Further, chloros, if used too strong, might have an injurious as well as a bleaching action. My only hesitation in recommending chlorine compounds as regards the disinfection of linen is that I have no data with reference to the limits of their harmful action on this material. Their powerful germicidal properties are beyond question.

[21] In the London County Council experiments previously referred to, we found corrosive sublimate 1 in 1000 (24 hours) effective as regards the destruction on linen of B. typhosus, B. pyocyaneus, V. choleræ, S. aureus, anthrax spores, and the tubercle bacillus. Carbolic acid 1 in 20 (24 hours) proved also effective except as regards spores of anthrax. Bleaching powder 1 in 100 likewise yielded on the whole good results.

[22] Dr. Parsons says (see Appendix A), "For articles that will stand it, washing in boiling water (with due precautions against re-infection), may be relied on as an efficient means of disinfection. It is necessary, however, that the grosser dirt should be removed by a preliminary soaking in cold water. This should be done before the linen leaves the infected place."

[23] Although a much lower temperature (about 70° C.) would be sufficient to destroy the microbes of ordinary infectious diseases, it is perhaps as well to allow a wide margin for possible error.

[24] About 70° C. would probably be quite sufficient, but 100° C. is recommended.

[25] "Goulstonian Lectures on Enteric Fever," by Dr. P. Horton Smith.

[26] "Izal Oil as an Intestinal Disinfectant," by Dr. M. H. Gordon, the "Lancet," March 8, 1902.

[27] A point was raised in the discussion by Dr. Shelly, namely, the proper method of gargling, and Dr. Shelly explained that few people seemed to know that closing the nostrils is a most useful accompaniment to the process.

[28] "Treatment of Wounds with Izal," by Mr. Bruce Clarke, M.B., F.R.C.S., "Lancet," July 1, 1893.

[29] The relatively innocuous character of Izal renders it a useful disinfectant for this purpose. The amount of liquid actually required to sponge the whole body is very small—less than 100 c.c.

[30] "Report of the Medical Officer, Local Government Board," 1884. Appendix B., No. 10. "Report on Disinfection by Heat," by Dr. Parsons.

[31] Extract from Dr. Sternberg's "Manual of Bacteriology," p. 201, *et seq.*

[32] "Report of the Medical Officer, London County Council—Experiments on Disinfection," 1902. For detailed information the Report itself must be consulted.

[33] Sanitary Institute Congress at Leeds, 1897. "The Disinfection of Rooms by Formic Aldehyde Vapours," by Dr. H. R. Kenwood.

[34] "Journal of State Medicine," 1898, "Some Experiments on the Disinfection of Rooms by Gaseous Formaldehyde," by Professor Sheridan Délépine.

[35] "British Medical Journal," February, 1895, "A Report on the Disinfection of Tubercle Infected Houses," by Drs. Sheridan Délépine and Arthur Ransome.

[36] Professor Sheridan Délépine has since found that this difficulty can be overcome.

[37] "Journal of State Medicine," April, 1900, "Experiments on Disinfection by Rapid Currents of Saturated Steam at Low Pressure, and with a new form of Steam Disinfector," by Professor Sheridan Délépine.

[38] "British Medical Journal," April, 1898, "The Disinfection of the Excreta," by Drs. Hill and Abram.